AGING SYSTEMS AT SLAC
AGING SYSTEMS AT SLAC

LCLS, built in 2008
AGING SYSTEMS AT SLAC

SPEAR3, built in 2004
AGING SYSTEMS AT SLAC

SLAC IS OLD

- Linac tunnel constructed in 1964 (pictured)
- First beam in the linac in 1966
- Pre-dates computerized control systems
- Pre-dates single-chip CPUs
- Pre-dates Programmable Logic Controllers
- Far surpassed lifespan expectations
AGING SYSTEMS AT SLAC

1966

1974

2010
SLAC TIMELINE

1966
- PEP

1980
- SLC Upgrade
  - “SCP” Control System
  - CAMAC Hardware
  - New Timing System
  - New Machine Protection System

1985

1998
- PEP-II

2008
- LCLS Upgrade
  - EPICS Control System
  - VME Hardware
  - New Timing System
  - New Machine Protection System

2018
As time goes on, the number of different technologies to support grows:

- Variants on a type of system
- Software packages
- “Quirks” to memorize
figure: skeleton of a baleen whale
(Pelvic bone circled)
Control system interfaces for decommissioned equipment

Obscure equipment that serves no function, but will trip the beam off when it fails
EXAMPLE: PPYY RELAY

- Backup shut-off path for the SLC/PEP-II Machine Protection System’s beam loss monitors. Stops broadcasting timing pattern to all devices.

- In the LCLS era, none of the loss monitors tied the PPYY relay existed in areas with beam. However, the relay still had spurious trips a few times per year.

- Status for the PPYY relay, and the reset button, requires navigating through a series of obscure, poorly labeled, visually indistinct panels.
<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>System</th>
<th>Description</th>
<th>Status</th>
</tr>
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<tbody>
<tr>
<td>09/28</td>
<td>09:18:04</td>
<td>PPS</td>
<td>NEH Hutch 2 Stopper S2.2</td>
<td>OK</td>
</tr>
<tr>
<td>09/28</td>
<td>09:14:55</td>
<td>PPS</td>
<td>NEH Hutch 2 Search Reset</td>
<td>SET</td>
</tr>
<tr>
<td>09/28</td>
<td>09:11:48</td>
<td>PPS</td>
<td>XRT Search Reset</td>
<td>NOT_SET</td>
</tr>
<tr>
<td>09/28</td>
<td>09:11:41</td>
<td>PPS</td>
<td>XRT ACCESS STATE</td>
<td>CONTROLLED</td>
</tr>
<tr>
<td>09/28</td>
<td>09:11:21</td>
<td>PPS</td>
<td>XRT SH2.1</td>
<td>NOT_IN</td>
</tr>
<tr>
<td>09/28</td>
<td>09:11:21</td>
<td>PPS</td>
<td>XRT SH2.2</td>
<td>IN</td>
</tr>
<tr>
<td>09/28</td>
<td>09:09:06</td>
<td>BCS</td>
<td>B911 BX3/BYD - DTC 1</td>
<td>OK</td>
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<tr>
<td>09/28</td>
<td>09:01:10</td>
<td>BCS</td>
<td>B911 BX3/BYD - DTC 2</td>
<td>FAULT</td>
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</tbody>
</table>
AGING SYSTEMS AT SLAC

EXAMPLE: SPEAR3 "WOLF BOX"
AGING SYSTEMS AT SLAC

EXAMPLE: SPEAR3 “WOLF BOX”
Linac VSWR (Voltage Standing Wave Ratio) alarm originally indicated a klystron reflected energy issue.

The VSWR interlock shuts off the linac klystron, which is also a convenient way to shut off the beam.

Many other systems (Average Current Monitors, Ion Chambers, etc) were wired into the VSWR interlock.

Reflected energy is almost never a problem, so the klystron’s VSWR is almost never the problem.
“WOLF BOX” DOCUMENTATION

- Extensive wiki documentation for every alarm channel (more than 7000 words!)
- Explains what can cause each alarm and how to respond (who to contact, what to document, how to reset)
- Painstakingly researched and written by a brand-new operator who was fed up with the chaos of the alarm system.

How to Respond

As stated in the overview there are many common BCS faults that are tied into the VSWR chain to the supply to the gun and linac, so I have listed some of the more common faults:

- There is a BSOIC located above the linac room, which is tied into this BCS chain (most common)
- There are 3 ACM’s that will trip the VSWR if a high current reading is recorded (read more about the ACM section of this page)
- Chopper Interlock faults
- Modulator faults

The general procedure to follow if your get a VSWR fault is to first find out the exact cause of the VSWR fault by getting individual piece back to normal operating conditions, and then finally reset the VSWR fault example, if the BSOIC above the linac tripped, you would first try and reset the BSOIC (after following...
AGING SYSTEMS AT SLAC

EXAMPLE: THE KLYSTRON SYSTEM

- 8 major components
- Operator interface in control room:
  - One on/off control
  - Three status indicator lights
AGING SYSTEMS AT SLAC

EXAMPLE: THE KLYSTRON SYSTEM

- 16 major components
- CAMAC controls hardware
- Nearly every piece has a control system interface
AGING SYSTEMS AT SLAC

EXAMPLE: THE KLYSTRON SYSTEM

- 23 major components
- CAMAC and VME hardware, each using a different control system
- Much of the old phase control hardware still exists, and is controllable, but its purpose has been supplanted by new LLRF system
MITIGATING COMPLEXITY

- “Operations Klystron Panel” UI that handles some of the differences between old and new-style stations, providing a single interface
- Documentation in our Operations Wiki
- Training
- But, still pretty challenging.
Strategies for Dealing with Old and Complicated Systems

Training

Excerpts from the “ASO-1 Qualification Workbook”
AGING SYSTEMS AT SLAC

STRATEGIES FOR DEALING WITH OLD AND COMPLICATED SYSTEMS

Documentation

Main Page

MCC Operations Wiki

News
9/21/2018 Added Wolf Box Alarm information page (SPEAR)
9/5/2018 Added BSY search animation PPTX to Training -> PPS Training
9/28/2018 Matterport Scan of LCLS Undulator Hall &
6/9/2018 ACR Daily Shutdown/Startup
5/14/2018 Reposting our favorite equation since it disappeared from the main page

\[ \lambda_0 = \frac{\lambda u}{2\gamma^2 \left( 1 + \frac{K^2}{2} \right)} \]

04/25/2018 Added Wide X-ray Bandwidth.
02/13/2018 Added Pulling Fast and Slow valves.

Operations Group Wiki

"MCCVideos" Video Database

Sector 20 Optics and Tuning by Nate Lipkowitz on 2012-11-30

Nate discusses how to tune the beam for the experiments in sector 20. The optics which match the linac’s FODO lattice into the W chicane in Lt1B are described, as are the diagnostic tools available (bunch length monitor, wire scanner). The scavenger extraction line is also covered. The operation of the HLM is presented. Ways to evaluate beam quality based on the PR-185 image are discussed. The w chicane optics, R56 of the chicane, and chromatic corrections from the sextupoles are shown. Sextupole tuning is discussed. SYAG, a profile monitor which can look at either synchrotron light from the FACET beam, or the FACET beam itself, is mentioned as a diagnostic tool. Strategies for tuning to minimize spot size are offered.

Damping Ring Setup and Tuning by Jerry Yocky on 2012-11-16

FACET Upgrades and Changes - Preparations for Run 2 - Part 2 by Nate Lipkowitz on 2012-11-09
STRATEGIES FOR DEALING WITH OLD AND COMPLICATED SYSTEMS

Operator-created (or operator edited) Control System Displays

Operator Klystron Panel

Reminder notes written on control panels
THANKS!

Acknowledgements:

- Howard Smith, Peter Schuh, William Colocho, Danielle Sanzone, and Lauren Alsberg for their helpful conversations about this subject
- Vikram Tharakan for the Wolf Box wiki page
- Shawn Alverson for the gigantic flashing “PPYY” text